Risø årsberetning 1981

Forsøgsanlæg Risø, Roskilde

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1982

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RISØ

1981


Radioaktivt stof
FORSØGSANLÆG RISØ
Kemiafdelingen
Uran-Carbonat
Ca. 10%
PYREX
MADE IN ENGLAND

Forside: Kemiske prøver fra grønlandsk uranmalm
Cover: Chemical samples from Greenlandic uranium ore

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Kvanefjelds rester
Remainings of uranium ore

meteorologiske verdensorganisation (WMO) og andre FN organisationer.

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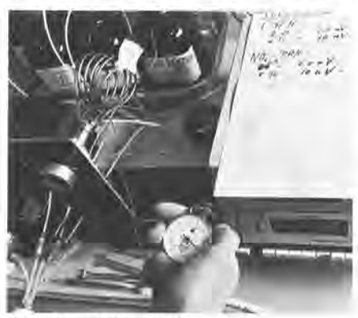

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Chemical reaction measurement

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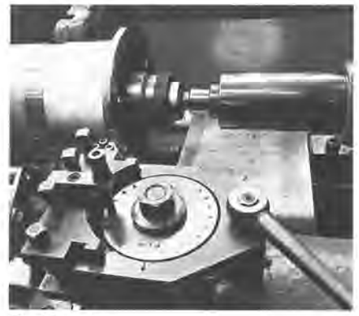

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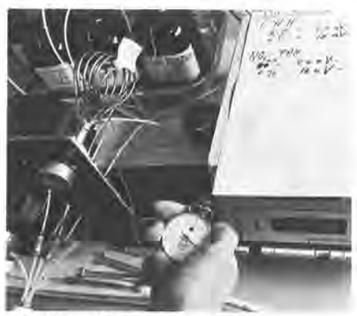

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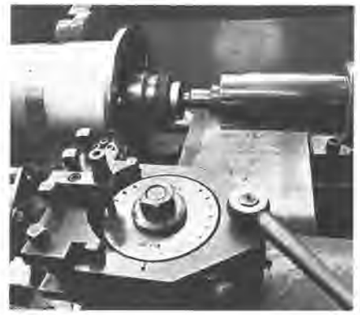

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Flittige bakterier

Landbrugets gødningsforbrug kan formindskes

Kvælstof er en afgørende faktor i landbrugets planteproduktion. Gødskning med kvælstof er en væsentlig forudsætning for det høje udbytteniveau i dansk planteavl. Kvælstofgødskning er samtidig den største enkeltpost på dansk landbrugs energiregnskab, svarende til omkring en halv million tons olie pr. år eller en fjerdedel af landbrugets totale energiforbrug. Risø har i en årrække arbejdet med at belyse mulighederne for at sikre en tilstrækkelig kvælstofmængde til planteavlen under anvendelse af mindre mængder fossil energi. En mulighed her er en øget dyrkning af bælgplanter.

Kvælstof fra knolde

Bælgplanter som f.eks. ærter, bønner eller kløver behøver ikke at få tilført kvælstofgødning, fordi de selv kan optage store mængder kvælstof fra luften. Dette sker ved hjælp af bestemte jordbakterier, *rhizobier,* som findes i små knolde på planternes rødder. I knoldene omdannes luftens kvælstof til ammoniak, som siden indbygges i planternes protein.

Selv om bælgplanternes evne til at forsyne sig selv med kvælstof er velkendt, dyrkes de for tiden kun i beskedent omfang, bl.a. fordi udbyttet er meget forskelligt fra år til år. Men bælgplanter er i stand til at levere kvælstof til naboplanter. I en kløvergræsmark får græsset kvælstof fra rådnende kløverrodknolde.

Byg og ærter

Risø undersøger, om et lige så gunstigt samspil kan opnås i andre afgrøder. Arbejdet gennemføres med støtte fra energiministeriets forskningsprogram. Foreløbige resultater tyder på et positivt samspil mellem byg og ærter, der dyrkes i blanding. Udbyttet bliver dog ikke så stort som i en normalt gødet bygmark, men energiforbruget er langt mindre. En blanding af ærter og korn er samtidig et bedre foder end korn alene, fordi proteinindholdet er højere. Derved kan import af soyabønner fra udlandet spares.

Udtynding i ærtebedet
Thinning out the peas

Rhizobiumbakterier til ærter, bønner og kløver findes normalt i danske jorde. Men det viser sig, at indholdet af rhizobier er meget forskelligt fra egn til egn, og det er kendt, at visse rhizobie-stammer er særdeles effektive kvælstofsamlere, medens andre nærmest snylter på bælgplanten. Risø undersøger, hvor effektive forskellige rhizobie-stammer er i samdrift med ærter. Desuden undersøges, om det er realistisk at tilsætte effektive rhizobier til jorden i større skala.

Frigjort kvælstof

Hvis gødningen mærkes med den ikke-radioaktive isotop kvælstof-15, er det muligt at skelne, om ærterne får kvælstoffet fra luften, jorden eller gødningen.

Forsøgene på Risø har vist, at en god ærteafgrøde indeholder omkring 200 kg kvælstof pr. hektar, hvoraf op til 2/3 er optaget fra luften. Den største del af kvælstoffet findes som protein i selve ærterne, men en betydelig del findes i ærtehalmen, som indeholder mere end 1% kvælstof. Ærtehalmens nedbrydning i jorden undersøges derfor. Man kan så vurdere mulighederne for at udnytte det kvælstof, der herved er frigjort, i efterfølgende afgrøder som vinterraps eller vinterhvede.

Fine ærter

Ærter og rhizobiumbakterier samarbejder altså om at binde kvælstof fra luften. Man ved efterhånden en del om, hvilke egenskaber en effektiv rhizobiumbakterie skal have, mens man endnu ikke ved så meget om, hvordan en ært skal være for at være en god kvælstofbinder. Risø undersøger, hvilke egenskaber man skal stræbe efter i en god ærtesort. Resultaterne tyder allerede nu på, at der er væsentlige forskelle på ærter til foder og grønærter til konsum.

Med baggrund i de senere års energikriser og stærkt stigende priser på kvælstofgødning må der forventes en stigende interesse for dyrkning af bælgplanter. Dette vil mindske behovet for olie og naturgas til produktion af kvælstofgødning og samtidig øge den hjemlige produktion af planteprotein.

Gødskning i marken *Fertilization of the field*

Busy bacteria

A research programme at Risø investigates the possibility of reducing the need for fossil energy in nitrogen fertilizers by improving the symbiotic nitrogen fixation in seed legumes. The consumption of nitrogen fertilizer is the largest single item in the energy budget of Danish agriculture, equivalent annually to about a half million tons of oil.

Legumes do not need nitrogen fertilizer as they can utilize nitrogen from the atmosphere by symbiosis with the soil bacterium, rhizobium. Some legumes are also able to supply their neighbours with nitrogen indirectly, like the rotting clover does to the grass in a clover-grass field. At Risø, we investigate if it is possible to establish a similar positive cooperation in annual crops such as pea and barley. Positive interactions have been obtained when pea and barley were grown in mixtures, especially if the nitrogen content in the soil was low. Although the total yield of biomass was lower than from a fully fertilized barley crop, the yield of protein was considerably increased, and the biomass production per unit of nitrogen fertilizer was improved.

Cultivated Danish soils vary considerably in the number of rhizobia grown per gram. The efficiency of rhizobia in inoculants and of native strains is investigated by the acethylene reduction method. Nitrogen-15 is used in determining the amount of nitrogen deriving separately from air, soil, and fertilizers.

We also investigate the interaction between pea cultivars and rhizobium strains and try to establish criteria for defining good nitrogen fixing pea cultivars.

This research project is supported by a Ministry of Energy grant.

Forsøg i væksthus *Experiment in the greenhouse*

Det er svært at spå

...også om fremtidens energiforbrug

Planlægning på energiområdet har gjort det nødvendigt at udvikle et specielt værktøj, som kaldes energi-økonomi-modeller. Modellerne kan f.eks. beregne energiforbrugets udvikling som konsekvens af forskellige forudsætninger om samfundets økonomiske udvikling. Den moderne databehandling gør det muligt hurtigt at få overblik over, hvordan ændrede forudsætninger kan ændre forbruget. Risøs energisystemgruppe arbejder med udvikling og anvendelse af sådanne modeller i Danmark.

Formålet med modellerne er at give det bedst mulige grundlag for planlæggere og beslutningstagere. Det er f.eks. vigtigt at have et realistisk skøn over, hvordan elforbruget vil udvikle sig i de kommende år. Det er nødvendigt at være forudseende, da det tager adskillige år at opføre et nyt kraftværk. Modellerne kan også benyttes i vurderingen af, hvad der kunne være den samfundsøkonomisk rimeligste anvendelse af naturgassen, nu og i fremtiden.

Risøs edb-anlæg
Risø's computer facility

Energi og økonomi

Det er nødvendigt at have et grundigt kendskab til energianvendelsen og -økonomien nu, hvis man vil lægge planer for fremtiden. Hurtig og let adgang til et meget detaljeret materiale fra f.eks. det danske nationalregnskab er helt afgørende, fordi ingen model bliver bedre end de informationer, den bygger på. Med selv de bedste modeller kan man ikke forudberegne fremtiden. Der er mange og store usikkerheder, som f.eks. kan skyldes påvirkninger fra udlandet. Ikke desto mindre kan modellerne belyse, hvad der formentlig vil ske i Danmark, hvis udviklingen i resten af verden forudsættes at forløbe på en række forskellige måder.

Et af de projekter, som Risøs energisystemgruppe arbejder med, betales af EF. Formålet er at udvikle edb-modeller til brug i EF-kommissionens arbejde med prognoser og planlægning for energi og økonomi. Modellerne skal derfor dække alle EF-landene samlet, men det er håbet, at de enkelte lande også kan gøre brug af modellerne.

Med nogle af energimodellerne prøver EF at se frem til 1990, medens andre rækker 20-30 år frem i tiden. Både efterspørgsel og forsyning med energi bliver vurderet. Når man prøver at se frem på den anden side af år 2000, kan man ikke klare sig med at forlænge den hidtidige udvikling, uanset hvor godt man kender den. Det må forventes, at der kan komme fundamentale omlægninger af energianvendelsen, bl.a. ved politiske indgreb. Derfor er det nødvendigt at opstille en række antagelser både af social og økonomisk art.

De seneste resultater beregnet med en af EF-efterspørgselsmodellerne viser, at der sandsynligvis i perioden frem til 1990 vil være en moderat vækst i efterspørgselen efter energiråstoffer i Danmark på 1,7% om året. Omlægningen til kul vil fortsætte. Endvidere vil elforbruget fortsat stige, omend med en svagt faldende vækstrate. Disse beregninger bygger på en række forudsætninger om den økonomiske og tekniske udvikling, og har derfor betinget gyldighed.

Planstudier *Studies of the energy scene*

El og varme

En af de andre energimodeller, som Risø arbejder med, vedrører Danmarks totale energianvendelse. Modellen bruges i særlig grad til opgaver for energiministeriet. Den bygger på prognoser for efterspørgselen i industri, transport, opvarmning o.s.v. Herudfra beregnes Danmarks samlede energibehov, og hvor meget det koster at opfylde dette behov. Denne energimodel kan også bruges til at analysere el- og kraftvarme-produktionen. Når elværkerne producerer både elektricitet og fjernvarme, er det et spørgsmål, hvor meget el og hvor meget varme, der skal produceres på hvilke anlæg og til hvilken tid. Først må man kende de enkelte værkers omkostninger til brændsel, og hvor godt de omsætter brændslet til el og varme. Med modellen kan man derefter finde den bedste kombination.

Energiplan 81

Modellen blev brugt af Det Økonomiske Råd, da Rådet i 1980 sammenlignede økonomien i kul- og kernekraft. Senest er modellen blevet anvendt som grundlag for regeringens Energiplan 81. Planen, der er udarbejdet af energiministeriet, angiver forskellige måder at forsyne Danmark med energi på. De økonomiske konsekvenser af valgmulighederne er beregnet ved hjælp af Risøs energimodel. Modellen har bl.a. beregnet, hvad udgifterne til den samlede danske energiforsyning vil blive i perioden 1981-2000, hvis man fortsat udbygger med kul-kraftværker, eller hvis man indfører kernekraft. Det er også beregnet, hvad udgifterne vil blive, hvis man satser stærkere på vedvarende energi, og hvis man bygger flere mindre kraftvarmeværker. Hermed er tilvejebragt et grundlag for de politiske beslutninger vedrørende den fremtidige udbygning af de danske kraftværker.

Prognose til EP-81 *Forecast to the Danish Energy Plan '81*

The expensive energy

Due to the drastic changes in the energy situation that has taken place during the 70's it has become essential to plan for future energy use, investigate new energy sources, and find new ways of conserving energy. The advent of energy planning has necessitated the development of special tools - the energy-economy computer models. These are used to calculate how much and what kinds of energy will be used in the future, given various assumptions about the development of society. Such models provide energy planners with the best basis on which to make decisions.

Since its formation in 1977, the Energy Systems Group at Risø has devoted considerable effort to the development and use of such models.

An important prerequisite for these models is detailed and comprehensive statistics on energy use and economic activity.

However, even with the most detailed knowledge of the past it is not possible to foresee the future with certainty. For this reason, the models are generally used for calculating the consequences of a number of alternative futures.

The Energy Systems Group participates in the European Commission's energy modelling effort. This involves the development and use of a number of models that can be used to predict the energy supply and demand situation up to 30 years in the future.

One of the other models which Risø works with can be used to simulate the total energy system in Denmark. This means making predictions of the energy demand for industry, transport, domestic heating, etc. and calculating how this demand is satisfied, year by year, for the period in question. The model takes particular account of the electricity generating system which is intimately connected with domestic heating because of the widespread use of district heating from combined heat and power stations in Denmark.

The model was used most recently in the Danish Energy Plan 81 to calculate the economic consequences of a number of future supply options.

Miljøkemi

Ved produktion, omsætning og anvendelse af energi sker der ofte en spredning af stoffer, som er belastende for miljøet og sundhedsskadelige for mennesker. Risøs kemiafdeling arbejder med at undersøge, hvad der sker med miljøet ved forskellige former for energiproduktion. Risø har særligt interesseret sig for luftforurening og for forurenende stoffers spredning med grundvandet.

Kul

Ved forbrænding af kul, olie og gas sendes mere end 1000 forskellige stoffer ud i luften. Flere af disse stoffer har vist sig at være kræftfremkaldende og/eller mutagene, dvs. de kan påvirke arveanlæggene. Den stofgruppe, som først og fremmest er i søgelyset, betegnes polycyclisk organisk materiale, eller blot POM.

Energiministeriet støtter et forskningsprojekt på Risø, som skal afklare, hvor meget POM der dannes ved forbrænding af kul. Det formodes, at en stor del af de mutagene stoffer i svævestøv fra kulfyrede anlæg stammer fra visse POM-forbindelser. I projektet undersøges, hvilke kemiske processer POM undergår i atmosfæren. Man arbejder også med at måle, hvor omfattende denne form for luftforurening er i øjeblikket.

Sollys

I løbet af tresserne og halvfjerdserne opstod et nyt luftforureningsproblem i Europa. Selv i afsidesliggende områder kunne der om sommeren være dage med reduceret sigtbarhed og relativt høje koncentrationer af ozon. Forklaringen er, at sollyset indvirker på forurenet luft og sætter gang i en række kemiske processer.

Fænomenet kaldes fotokemisk luftforurening. Omfanget af denne type luftforurening kan måles ved hjælp af et stof, der kaldes peroxyacetylnitrat eller PAN. Målinger med PAN er imidlertid problemfyldt, fordi stoffet i ren tilstand er eksplosivt. Risø har i samarbejde med Miljøstyrelsens Luftforureningslaboratorium udviklet en ny metode, som løser dette problem. Den nye målemetode har allerede vist sin duelighed ved målinger af fotokemisk luftforurening flere steder i Skandinavien. Undersøgelserne viser, at denne specielle form for luftforurening kun dannes sjældent på vore breddegrader, men at forureningen i vidt omfang kommer hertil fra andre steder i Europa.

Freon

En stor del af den løbende debat om luftforurening har beskæftiget sig med nedbrydningen af jordens beskyttende lag af ozon. Ozonlaget findes i ca. 20 km's højde og bremser det sundhedsfarlige ultraviolette lys fra solen. Den form for luftforurening, man er mest bekymret for i denne forbindelse, skyldes freon.

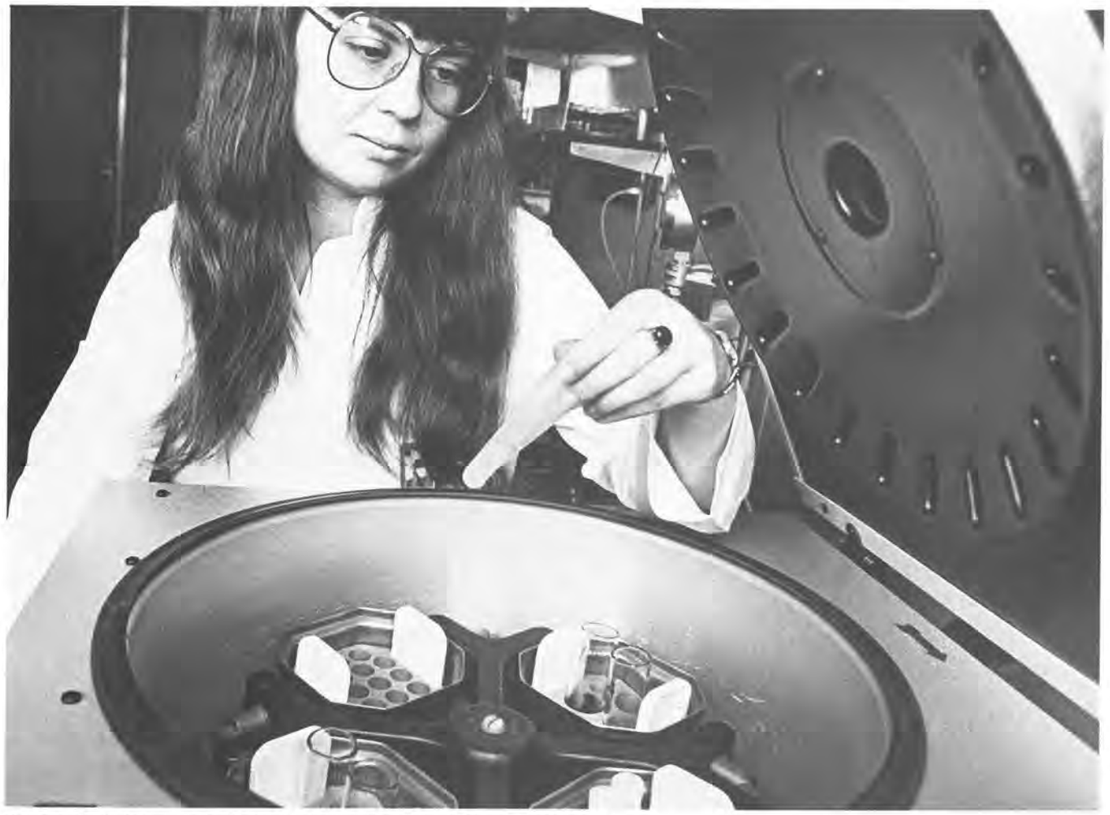
Store mængder af freon frigøres ved brug af spraydåser, hvor freon benyttes som drivgas. Freons særlige egenskaber udnyttes også i stor stil i kølemaskiner og varmepumper. Der er derfor vigtigt at måle, hvor meget freon betyder for nedbrydningen af ozon-laget. Det kan bedømmes ved hjælp af store EDB-modeller, som beregner samspillet mellem de flere hundrede kemiske reaktioner, der foregår i atmosfæren. Men for at modellerne kan regne rigtigt, må de bygges på målinger af, hvor hurtigt de forskellige kemiske reaktioner forløber.

På Risø benyttes en særlig nøjagtig metode, puls-radiolyse, til bestemmelse af kemiske reaktionshastigheder. I forbindelse med en kortvarig bestråling af den kemiske prøve i nogle milliardedele af et sekund kan man måle, hvor hurtigt de kemiske forbindelser dannes og henfalder. Metoden har væsentlige fordele fremfor andre metoder, men den anvendes endnu kun meget få steder i verden. Risø har derfor kunnet yde et bidrag til en forøget viden om disse reaktionshastigheder og dermed spørgsmålet om freons nedbrydning af ozon-laget.

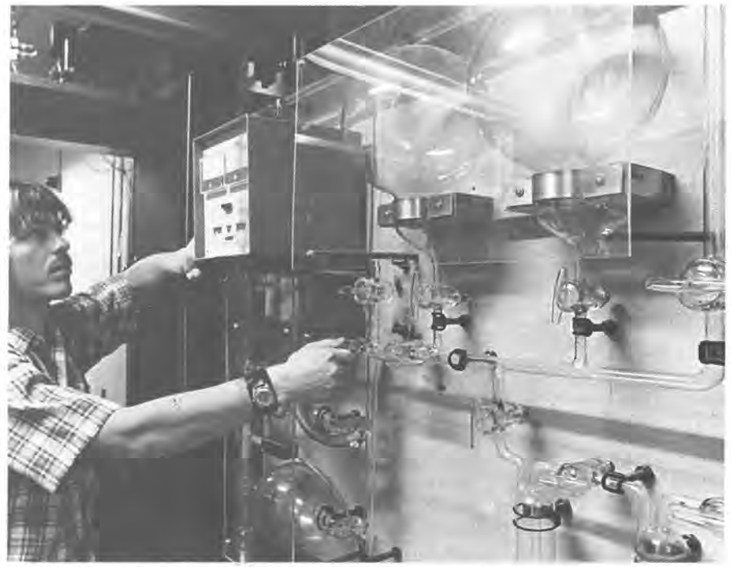
Grundvand

Megen forurening spredes med grundvandet. Derfor har man længe arbejdet med at kortlægge, hvordan denne spredning finder sted. Særligt aktuelt er spørgsmålet blevet i forbindelse med overvejelserne om eventuel deponering af radioaktivt affald i dansk undergrund.

Det har vist sig, at forurenede stoffer spredes på samme måde med grundvandet, uanset om de er radioaktive eller ej. Men radioaktive stoffer er meget velegnede som sporstoffer, hvis man vil gøre forsøg med grundvandsspredning. Det skyldes, at radioaktive stoffer kan måles i meget små mængder og i øvrigt taber radioaktiviteten med tiden.



Forurenede jordprøver centrifugeres *Polluted soil samples are centrifuged*



Reaktionshastigheder måles *Rate constants are measured*

Risøs arbejde på dette felt har derfor kunnet anvendes langt udover spørgsmålet om deponering af radioaktivt affald. Resultaterne har f.eks. været anvendt til at beskrive, hvordan forurening med tungmetallerne bly, cadmium og kviksølv kan udbrede sig.

Environmental chemistry

The combustion of organic material such as coal, wood, and petrol results in the emission of more than one thousand different organic compounds. Some of these have been shown to be carcinogenic and/or mutagenic. Most of these compounds belong to the so-called polycyclic organic matter (POM) group. The aim of an environmental research project at Risø is to investigate the contribution from the combustion of coal to the presence of these compounds in the atmosphere. In addition, the atmospheric chemistry of the important group known as polycyclic aromatic hydrocarbons (PAH), especially their reaction with nitrogen oxides and the corresponding acids, is studied by means of model experiments in the laboratory and field measurements.

In another research project, photochemical air pollution using peroxyacetyl nitrate (PAN) as an indicator has been investigated in collaboration with other Scandinavian groups. A convenient method has been developed for the preparation of pure standards of PAN for calibration of the gas chromatograph used in the atmospheric measurements.

In connection with the evaluation of the impact of chlorofluorocarbons on atmospheric ozone, large international computer models have been developed. In order for these models to be reliable precise experimental measurements are needed of rate constants for the more than 100 chemical reactions involved. At Risø, rate constants for relevant atmospheric reactions are determined by pulse radiolysis combined with kinetic spectroscopy. This method has several advantages as compared to more conventional methods and is used at only a few other laboratories in the world.

For several years geochemical studies have been performed at Risø of migration phenomena related to possible geological disposal of nuclear waste. The techniques developed are directly applicable to transport studies of all kinds of non-radioactive groundpolluting species, such as lead, cadmium, and mercury.

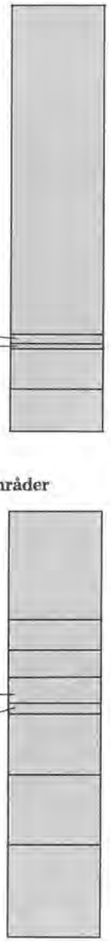
Målestation for luftforurening
Air pollution monitor

Regnskab 1981

Annual Accounts 1981

Udgifter 1981
242,1 mill. kr. = 100%

Indtægter 1981
242,1 mill. kr. = 100%



Udgifter fordelt på arbejdsområder (budget 1982)

Udgifter *Expenditure*	Regnskab 1980 Accounts 1980	Regnskab 1981 Accounts 1981	Budget*) 1982 Budget 1982
	mill. kr.	mill. kr.	mill. kr.
Løn til medarbejdere	123,0	**139,2**	151,4
Teknisk-videnskabelig uddannelse på Risø	3,9	**4,3**	4,6
Lønninger, i alt *Wages and Salaries, totally*	126,9	**143,5**	156,0
Køb af materialer	15,2	**19,3**	18,7
Anskaffelse af materiel	22,9	**28,4**	20,5
Reaktorbrændsel	3,8	**8,1**	5,9
Materialer og materiel, i alt *Materials and Equipment, totally*	41,9	**55,8**	45,1
Tjenesterejser og befordring	3,3	**4,4**	5,8
Kontorhold m.v.	3,6	**4,3**	4,3
Olie og el	6,9	**9,4**	9,0
Reparation og vedligeholdelse	3,4	**5,6**	3,9
Diverse driftsudgifter *Miscellaneous Expenditure*	17,2	**23,7**	23,0
Fremmede tjenesteydelser	14,6	**13,1**	14,2
Skatter og afgifter	1,4	**1,5**	1,8
Fremmede tjenesteydelser m.v. *Outside Services*	16,0	**14,6**	16,0
Anlægsudgifter *Buildings etc.*	7,3	**4,5**	26,5
I alt udgifter *Total Expenditure*	209,3	**242,1**	266,6
Indtægter/*Income*			
Statens direkte andel af driftsudgifter *The Direct Contribution from the Government to Running Expenses*	161,6	**188,2**	194,3
Statens direkte andel af anlægsudgifter *The Direct Constribution from the Government to Buildings etc.*	7,3	**3,9**	26,0
Kantine, lejeindtægter m.v. *Canteen, Rentals etc.*	2,3	**2,3**	2,4
Kommercielle kontrakter m.v. *Commercial Contracts etc.*	19,1	**24,1**	25,1
Energiministeriets forskningsprogram *The Programme for Research and Development of the Ministry of Energy*	19,0	**23,6**	18,8
I alt Indtægter *Total Income*	209,3	**242,1**	266,6

*) budget pr. 1. juni 1982

Risøs bestyrelse direktion, afdelinger m.m.

Guide to the Risø National Laboratory

Bestyrelse
Board Members

Departementschef Erik Ib Schmidt (formand)

Departementschef Ole Bech
Energiministeriet

Dr. techn. Torben Leffers*)
Forsøgsanlæg Risø

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Forsøgsanlæg Risø

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Nordiske Kabel- & Traadfabriker A/S

Kontorchef Ib Skovgaard
Landbrugsrådet.

Overingeniør
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Landsorganisationen i Danmark

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Haldor Topsøe
Haldor Topsøe A/S

Bestyrelsens sekretær:
Dr.ing. Klaus Singer

*) Udpeget pr 1/6 1982

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Management

Direktør, lic.techn.
Niels E. Busch

Underdirektør cand.scient, HD
Lars Kolind

Underdirektør, civilingeniør
Ingvard Rasmussen

Direktionssekretær, dr.ing.
Klaus Singer

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Departments, etc.

Acceleratorafdeling
Civilingeniør K. Sehested

Administration og forvaltning
Cand.jur. N. Bundgård

Behandlingsstation
Civilingeniør Knud Brodersen

Bibliotek
Bibliotekar Eva Pedersen

DR 1
Civilingeniør Jørgen Olsen

DR 3
Civilingeniør Heinz Floto

Elektronikafdeling
Civilingeniør Jens Rasmussen

Energisystemgruppe
Civilingeniør Hans Larsen

Fysikafdeling
Dr.phil. H. Bjerrum Møller

Helsefysikafdeling
Civilingeniør H.L. Gjørup

Hot cell anlæg
Akademiingeniør Helge Hougaard

Isotoplaboratorium
Dr.techn. Kaj Heydorn

Kantine og Gæstehjem
Bestyrerinde E. Thingstrup

Kemiafdeling
Civilingeniør B. Skytte Jensen

Konstruktionsafdeling
Civilingeniør
Christian Regenburg

Kontraktkontor
Ingeniør Oscar Holst Jensen

Landbrugsforsøgsafdeling
Dr.agro. Jens Sandfær

Metallurgiafdeling
Dr.techn. Niels Hansen

Oplysningssekretær
E.B. Mogensen

Personalekontor
Personalechef Jarl Bregninge

Reaktorteknikafdeling
Civilingeniør Bjarne Micheelsen

Regnemaskineanlæg
Civilingeniør L. Hansson

Sikkerhedskontor
Maskinmester Jørgen Christensen

Sikkerhedstjenesten
Civilingeniør Klaus Iversen

Økonomikontor
Cand.oecon. Erik Lassen

Risøs arbejdsområder

Risø's activities

Energiforsyning

Den største del af Risøs forskningsindsats ligger på energiområdet. Under overskriften energiforsyning er alene samlet projekter, hvor Risø har en fjerdedel af den totale omsætning. Det undersøges, hvorledes forskelige energiformer bedst kan udnyttes, f.eks. fossile brændsler, uran og vind. Risø arbejder også med, hvorledes energi kan lagres og transporteres, og på hvilken måde Danmark bedst kan kombinere de forskellige energikilder, der er til rådighed.

I dette arbejdsområde findes Risøs atomkraftækniske program. Atomkraftværkers opbygning, virkemåde, instrumentering, placering og drift studeres. Der foretages forsøgsudvinding af uran. Reaktorbrændsel undersøges og Risø bidrager til arbejdet om deponering og behandling af reaktoraffald.

De øvrige energiprojekter spænder fra fusionsforskning over kulforskning til afprøvning af mindre vindmøller.

Mange projekter er dele af internationale projekter, mens andre energiopgaver løses i samarbejde med dansk industri.

Energy supply

The major part of Risø's research covers a broad spectrum of energy projects. Under the energy supply heading projects are gathered which are responsible for a quarter of Risø's total cash turnover. It is investigated how the use of different energy sources like fossil fuel, uranium and wind can be optimized. Also, studies are going on to produce the cheapest and most efficient combination of the available energy sources.

In this activity area Risø's nuclear power program is found. The construction, operation, instrumentation and siting of nuclear power plants are studied. Experimental uranium extraction is performed. Reactor fuel is investigated and Risø contributes to the studies on handling and disposal of nuclear waste.

The other energy projects range from fusion research over coal research to testing of small windmills.

Many of the projects are parts of major international projects, while other energy investigations are performed in collaboration with Danish industry.

Miljø- og sikkerhedsforskning

De opgaver, der hører til dette arbejdsområde, kan samles i emnerne: miljøeffekter ved energiproduktion, industriel risikoanalyse, radiologi og meteorologi.

Miljøopgaverne omfatter bl.a. studier af kræftfremkaldende stoffer i røggassen fra kulfyring. Risø deltager også i en undersøgelse af, hvorledes en eventuel start af uranminedrift vil påvirke miljøet omkring Kvanefjeldet i Grønland, både økologisk og samfundsmæssigt.

Metoder til systematisk pålidelighedsog risikoanalyse anvendes til at vurdere driftssikkerhed af industrielle anlæg og risiko for skader på personer og miljø.

De radioøkologiske opgaver på Risø drejer sig om radioaktive stoffers omsætning i naturen, og specielt hvordan de optages i den menneskelige organisme.

Meteorologiforskningen er koncentreret om atmosfærens nederste lag, det såkaldte grænselag. Kendskab til dette lag er bl.a. nødvendigt for forståelsen af spredning af luftforurening, og for at vurdere mulighederne for at udnytte vindenergi.

Environmental and safety research

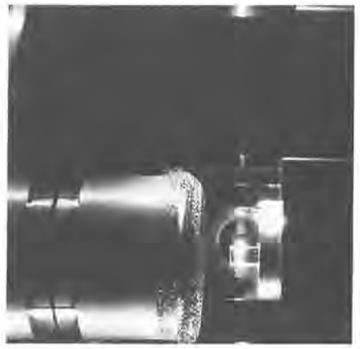
The projects belonging to this activity area can be divided into the following subjects: environmental effects of energy production, industrial risk analysis, radioecology, and meteorology.

The environmental studies include investigations of the importance of certain carcinogenic organic compounds present in smoke from combustion of coal. Risø also participates in a Danish investigation of how large-scale uranium mining would affect the biological and social environment in Greenland.

Reliability assessment techniques are used for evaluating the safety of industrial plants in order to achieve maximum security against human or environmental damage.

The radioecological studies aim at tracing radioactive isotopes in the environment and follow their potential routes to humans.

The meteorological research at Risø concentrates on experimental and theoretical studies of the planetary boundary layer. The research is applied to a number of practical tasks such as the exploitation of wind energy and studies of atmospherically dispersed pollution.



Materialeforskning

Risøs materialeforskning er både grundforskning og teknisk udviklingsarbejde. Inden for faststoffysikken arbejdes med materialernes struktur i atomarskala og med de kræfter, der binder atomer sammen. Arbejdet udføres ved at måle, hvordan neutroner fra DR 3 reaktoren afbøjes, når de rammer en materialeprøve. Målingerne kan suppleres med undersøgelser af røntgenstrålers afbøjning i de samme materialer.

Positron-annihilation er navnet på en teknik, der kan bruges til at give oplysninger om mikroskopiske uregelmæssigheder i materialers ellers regelmæssige atomstruktur.

Risø arbejder med undersøgelse af nye materialer til anvendelse ved høje temperaturer og med udvikling af nye plastmaterialer, der bliver forstærket af fibre af glas eller kul.

Forbedrede materialeegenskaber kan i nogle tilfælde opnås ved bestråling. Dette udnyttes f.eks. til overfladebehandling af silikonegummi. Undersøgelserne har betydning for stoffets forskelige anvendelser til medicinsk brug.

Materials research

Materials research at Risø comprises basic as well as applied studies.

Solid state physics research deals with the structure of materials and binding forces on an atomic level. This programme is based on neutron scattering experiments at the DR 3 reactor. X-ray scattering equipment is provided to complement that of neutron scattering.

The positron-annihilation technique yields information on dislocations and voids, e.g. caused by radiation damage, on an atomic level.

New materials are being developed for enhanced high-temperature resistance and tensile strength (glass or carbon fibre composites). The advantage of such materials is the combination of high tensile strength, stiffness, and low density.

In some cases material qualities may be improved by radiation. This is the case for silicone rubber, where surface radiation is important for medical use of the material.

Biologi og strålingsforskning

Risøs landbrugsforskning beskæftiger sig med planters arvelige egenskaber og gødningens og jordbundens betydning for planteproduktion.

Planteforædlingsarbejdet er koncentreret om byg, hvor man søger at finde bygformer, som har høj proteinkvalitet, og som er modstandsdygtige over for kulde og svampesygdommen meldug. Risø har udviklet en teknik - båndfarvning - hvorved hvert enkelt af byggens kromosomer kan bestemmes.

Inden for strålingsmikrobiologien har strålingen fra elektronacceleratorer længe været udnyttet til at sterilisere engangsudstyr til hospitaler. Mekanismerne, der forårsager bakteriernes død, er genstand for grundvidenskabeligt arbejde.

Elektronstrålerne benyttes også til at undersøge meget hurtige kemiske reaktioner. Disse undersøgelser omfatter reaktioner af stor betydning i biologien, nemlig synsprocessen og fotosyntesen.

Isotoplaboratoriet leverer alt reaktorbestrålet materiale til teknisk-videnskabeligt brug i Danmark og fremstiller radioaktive lægemidler til brug ved medicinske undersøgelser.

Biotechnology and radiation research

Agricultural research at Risø concentrates on problems of plant production, with barley, the most important crop in Denmark, as the object of chief interest. The work comprises plant genetics, soil fertility, and plant nutrition.

For a long time, radiation sterilization techniques have been used for sterilization of disposable utensiles in hospitals. The detailed mechanisms responsible for the lethal effect of radiation on bacteria are under investigation.

Extremely fast chemical reactions are studied by the pulse radiolysis technique using electron accelerators. The systems examined are important for understanding photosynthesis reactions and the seeing process.

The Isotope Laboratory at Risø is the sole producer and supplier of neutron-irradiated materials used for technical and scientific purposes in Denmark as well as for short-lived radiopharmaceuticals for medical diagnostics and treatments.

Måleteknik og analyse

Mange af Risøs forskningsprojekter har krævet udvikling af specielle metoder til måling og analyse af eksperimentelle prøver. Flere af disse målemetoder benytter Risøs særlige anlæg og anvendes af industrien og andre forskningsinstitutioner.

Neutron-aktiverings-analyser udføres på reaktoren DR 3. Inden for bl.a. geologi, økologi, arkæologi og medicin analyseres prøver af materialer for deres indhold af grundstoffer i små mængder.

I forbindelse med strålingsforskningen har Risø udviklet særlige instrumenter til måling af forskellige strålingstyper.

Lasermåleteknik benyttes i flere af Risøs projekter. Inden for meteorologien anvendes laseren til måling af lufttemperatur og vindhastighed på lang afstand, og i fusionsforskningen bruges laseren bl.a. til bestemmelse af temperaturer på flere millioner grader. Risø har opnået kontrakt på levering af et avanceret lasermålesystem til det nye fælleseuropæiske fusionseksperiment JET i England.

Risø har også lang tids erfaring med en række avancerede kemiske analysemetoder.

Experimental methods and analyses

Many of Risø's research projects have demanded the development of advanced methods of diagnostics and analysis. Several of these utilize Risø's exceptional research facilities and are available to outside customers.

For researchers in the medical, geological, ecological, and archaeological research fields, samples are analysed for traces of specific elements by neutron activation techniques.

In connection with the radiation research studies, specially developed dosimetry equipment is applied to measurements of radiation doses of differing characteristics.

Laser diagnostics is used in several of Risø's experiments. In meteorological research the laser senses air temperature and wind velocity remotely. Fusion experiments apply laser diagnostics to different tasks, in particular, the determining of temperatures of the order of several million degrees. Risø has a contract with the joint European fusion experiment, JET, to deliver an advanced laser diagnostic system.

Risø has also many years of experience with a long series of advanced methods for chemical analysis.

Store forsøgsfaciliteter

Risøs største forsøgsfacilitet, DR 3 reaktoren, kørte i 1981 med fuld effekt, 10 MW, i 77% af årets timer. Reaktoren, som benyttes i mange af Risøs forskningsprojekter, er en af de bedste til måling af materialers indre struktur ved hjælp af neutronspredning.

DR 1 reaktoren er langt mindre end DR 3. Den anvendes hovedsageligt til undersøgelser af den indre struktur af forskellige konstruktionsdele ved hjælp af gennemlysning med neutroner. En del af tiden bruges DR 1 til undervisningsformål.

Hot cell anlægget og metallurgiafdelingens teknologihal benyttes bl.a. i forbindelse med udviklingen af brændselselementer til kernekraftværker. Arbejdet udføres i samarbejde med Helsingør Værft A/S. I hot cell anlægget kan radioaktivt materiale undersøges bag tykke glas- og betonvægge ved hjælp af fjernstyret værktøj.

Acceleratorafdelingens elektron-acceleratorer og coboltbestrålingsanlæg anvendes i en række af Risøs strålingsforsøg. Anlæggene benyttes endvidere til bestrålingsservice for universitetsinstitutter, hospitaler og industrivirksomheder.

Major research facilities

Risø's largest research facility, the DR 3 reactor, was operated at full power (10 MW) during 77% of the year 1981. The reactor is used in many of Risø's advanced projects and is one of the world's foremost reactors for neutron scattering research.

The DR 1 reactor, much smaller (2 kW) than DR 3, is used primarily in studies of the internal structure of different construction elements by neutron screening. Part of the time DR 1 is used for educational purposes.

The hot cells and the Metallurgy Department's Technology Hall are used in development studies of fission fuel rods. This work is performed in collaboration with Elsinore Shipyard, Ltd. In the hot cells, radioactive material can be investigated behind thick glass and concrete walls by remote handling.

The Accelerator Department's electron accelerators and cobalt radiation facilities are used in a number of Risø's radiation experiments. These facilities are also employed in radiation service for university institutes, hospitals, and industrial concerns.

Tekniske støttefunktioner

De videnskabelige forskningsprogrammer og driften af de store forsøgsfaciliteter trækker på en række støttefunktioner.

Forskningsrådenes og Risøs Instrumenttjeneste (FRIT) vedligeholder det elektroniske målegrej og sørger for, at det bliver effektivt udnyttet ved genbrug i forskellige eksperimenter.

Risø råder over et anlæg til fremstilling af flydende brint og helium. Risø sælger flydende helium til universiteter og læreanstalter.

Behandlingsstationen bearbejder og oplagrer radioaktivt affald fra Risø og andre danske institutioner og virksomheder.

Risøs tegnestue og værksted fremstiller de specialkonstruktioner, som indgår i de eksperimentelle forsøg.

Biblioteket er offentligt og har landets største samling af energilitteratur.

Risøs regnemaskineanlæg bliver i stigende grad benyttet som værktøj i det videnskabelige arbejde. Et nyt og større EDB-anlæg vil blive installeret i 1982.

Technical support

The scientific programmes and operation of the large research facilities are supported by a multitude of auxiliary functions.

A collaboration agreement with the Danish National Research Councils puts Risø in charge of the acquisition of scientific research equipment, and its loan to and maintenance for the Risø laboratories as well as for other Danish research centres.

The handling and disposal of radioactive wastes from Risø and other users of radioactive isotopes in Denmark is taken care of at Risø.

Liquid helium is being produced at Risø for use there and at other Danish research laboratories.

Risø's Engineering Department designs and manufactures most of the specialized equipment for the experimental set-ups.

The central library is public and contains Denmark's largest collection of energy literature.

Risø's central computer is increasingly being used as a tool for the scientific and engineering work and a new and larger unit (a Burroughs 7800) will be installed in 1982.

Teknisk og administrativ service

Den service, der må være til rådighed for at kunne gennemføre projekterne i de 7 øvrige arbejdsområder, er samlet her.

Sikkerhedstjenesten overvåger, at nukleare og andre projekter udføres på betryggende måde. Risø har sit eget lokale brandvæsen samt sin egen skadestue, således at hurtig assistance kan ydes, hvis uheldet er ude. I 1981 er en bedriftssundhedstjeneste gældende for alle medarbejdere blevet oprettet. Risøs sikkerhedsorganisation har aktivt medvirket i en række arbejdsmiljømæssige opgaver.

Servicesektionen sørger for, at bygninger og anlæg vedligeholdes, og deltager også ved opførelsen af nye eksperimentelle faciliteter.

Risø driver også et reproduktionsværksted og et fotografisk laboratorium, foruden naturligvis sin egen kantine til de næsten 1000 medarbejdere.

Endelig sørger økonomi-, administrations- og personalekontorer samt direktionssekretariatet for nødvendige administrative og ledelsesmæssige fællesfunktioner.

Technical and administrative services

Under this heading are gathered the various service functions needed to operate a laboratory of the size and scope of Risø.

The safety group is in charge of both nuclear and conventional safety. It comprises a local fire squad, general health service, and 24-hour surveillance of the Laboratory from the gate house.

The service section is in charge of transportation, power, heating, building and road maintenance, etc.

Risø also runs a printing workshop, a photography laboratory, and its own staff restaurant.

Last but not least, the economy, administrative, and personnel offices together with the management secretariat take care of the joint administration and management of the Laboratory.

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